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The reachability information may be a single destination address or a plurality of addresses, such as the care-of addresses provided by a plurality of foreign agents in a mobile IP based system.

5   The invention further provides a mobile communications system comprising a mobile node, means for maintaining reachability information for the mobile node and means for receiving messages directed to the mobile node, characterised by a service controller configured to set a destination for a message directed to the mobile node when the reachability information indicates that the mobile

10   node is unreachable.

According to the invention, there is further provided a method of routing data directed to a mobile host which is away from its home network, comprising the steps of maintaining a record of locations through which the data can be routed

15   to the mobile host, and in the event that the data cannot be routed to the mobile host through any of the locations specified in the record, then routing the data to an alternative destination from which it is available for subsequent retrieval to the mobile host.

20   In accordance with the invention, there is also provided a mobile communications system comprising a mobile host movable between its home network and a plurality of connected communications networks, a router configured to route data intended for the mobile host to a location through which the data can be sent to the mobile host, when the mobile host is away

25   from its home network, and a service controller configured to intervene so as to send the data to an alternative location, when the data cannot be sent to the mobile host.

Brief Description of the Drawings

30   Embodiments of the invention will now be described by way of example with reference to the accompanying drawings, in which:

Figure 1a is a schematic diagram of the general arrangement of a conventional mobile IP based system;

Figure 1b shows the flow of data to a mobile node attached to a foreign network

5   in the system of Figure 1a;

Figure 2 is a schematic block diagram showing the registration of a mobile node with multiple foreign agents in a conventional mobile IP based system; and

Figure 3 is a schematic block diagram of a system according to the present invention for use with the method according to the present invention.

10

Detailed Description

Referring to Figure 1b, in a known IP based system such as the Internet, the home agent 7 plays a passive role in data transmission to the mobile node 6. When the home agent 7 intercepts a data message destined for the mobile node 6,

15   its only options are to tunnel the message to the mobile node 6 based on its

Claims

1.   A method of routing data directed to a mobile node (6) in a communications system, comprising the steps of:
maintaining reachability information for the mobile node; and
receiving data directed to the mobile node; characterised by
setting a destination (18,19a-n) to which the received data is to be sent
when the reachability information indicates that the mobile node is
unreachable.

2.   A method according to claim 1, wherein the data destination comprises a proxy node (18).

3.   A method according to claim 2, further comprising storing the data at said proxy node until the mobile node becomes available.

4.   A method according to claim 2 ~~or 3~~, further comprising instructing the proxy node to send received data to the mobile node when the reachability information indicates that the mobile node has become reachable.

5.   A method according to ~~any preceding~~ claim, comprising setting the data destination in accordance with a user preference.

6.   A method according to claim 5, wherein the user preference specifies the conditions in which the user specified destination is to be used.

7.   A method according to ~~any preceding~~ claim, wherein the reachability information comprises at least one destination address.

8.   A method according to ~~any preceding~~ claim, wherein the communications system comprises an Internet Protocol (IP) based system.

9.   A method according to claim 8, wherein the reachability information is maintained by a home agent router (7).

10.   A method according to claim 8 ~~or 9~~, wherein the destination address is a care-of address for the mobile node.

11.   A mobile communications system comprising:
a mobile node (6);
means for maintaining reachability information for the mobile node; and
means for receiving messages directed to the mobile node; **characterised by**
a service controller (13) configured to set a destination for a message
directed to the mobile node when the reachability information indicates
that the mobile node is unreachable.

12.   A method of routing data directed to a mobile host (6) which is away
from its home network (1), comprising the steps of:
      maintaining a record of locations through which the data can be
routed to the mobile host, and in the event that the data cannot be routed
to the mobile host through any of the locations specified in the record,
then routing the data to an alternative destination (18,19a-n) from which it
is available for subsequent retrieval to the mobile host.

13.   A method according to claim 12, further comprising storing the data
at said alternative destination until the mobile host becomes available.

14.   A mobile communications system comprising:
a mobile host (6) movable between its home network (1) and a plurality of
connected communications networks (2,3);

a router (7) configured to route data intended for the mobile host to a location (10,11) through which the data can be sent to the mobile host, when the mobile host is away from its home network; and

a service controller (13) configured to intervene so as to send the data to an alternative location (18,19a-n), when the data cannot be sent to the mobile host.

15.   A mobile communications system substantially as hereinbefore described with reference to the accompanying drawings.

16.   A method of routing data directed to a mobile node in a communications system, substantially as hereinbefore described with reference to the accompanying drawings.

(54) Title: PROXY ROUTING

(57) Abstract

A method of routing messages destined for a mobile node (6) in a communications system, such as the Internet, including sending the messages to a proxy node (18) according to reachability information recording the current of the mobile node (6), as well as user preference information provided by a service controller (13), which is able to divert an incoming message to an address specified by the user, and in the absence of current location information for the mobile node (6), can intervene to send an incoming message to a default location such as the proxy node (18).

Proxy Routing

Field of the Invention

The present invention relates to the routing of data within communications
networks, including but not confined to networks such as the Internet and
particularly, but not exclusively, to a method of routing data directed to a mobile
node. The mobile node may be a mobile host, such as a portable computer, or it
may be a router which is responsible for the mobility of one or more entire
networks, for example, the mobile data network within an aircraft. In either
case, the mobile node may change its point of attachment from one network or
subnetwork to another.

Background

The routing of data around the diverse networks which make up the Internet is
based on a protocol known as the Internet Protocol (IP). Data is transferred in
the form of data units known as IP datagrams between points in the Internet
specified by IP addresses. The detailed specification of IP is available in a
"Request for Comments" document, RFC 791, maintained by the Internet
Engineering Task Force (IETF). RFC documents are widely available on the
Internet at, for example, "ftp://ds.internic.net/rfc/rfcxxxx.txt", where "xxxx"
represents the RFC number, so that RFC 791 is available as rfc791.txt.

The current version of IP, known as IPv4, does not itself support mobility, but a
protocol entitled "IP Mobility Support", commonly referred to as Mobile IP, has
been designed to enhance IPv4 to support mobility. This protocol is described in
document RFC 2002, available as detailed above. The next generation of IP
(IPv6) is being specifically designed to deal with the mobility requirement.

IPv4 assumes that a node's IP address uniquely identifies the node's fixed point of
attachment to the Internet. If the node is transferred to a different point, it can
only be contacted by allocating it a new IP address. Mobile IP, however, enables

a mobile node, such as a laptop or palmtop computer, to send and receive IP

datagrams over the Internet regardless of the physical location at which it is

connected to the Internet and without changing its IP address. One example of

the mechanism by which it does so is illustrated in Figures 1a and 1b.

5

Referring to Figure 1a, the Internet comprises a large number of networks and

sub-networks 1, 2, 3, 4 connected via routers 5. A router may be a general

purpose computer programmed to perform routing tasks. Increasingly, routers

throughout the Internet are dedicated pieces of hardware provided by companies

10   such as Cisco Systems, California, USA. In either case, the functionality of a

router intended for use in an IP based network is defined in RFC 1812.

A mobile node (MN) 6 is normally connected to the Internet via a home

network 1. The unique IP address assigned to the node 6 is known as its home

15   address. Mobility agents, known as foreign agents (FA) and home agents (HA),

advertise their presence on a network via availability messages known as Agent

Advertisements. A mobility agent is typically a router connected to a particular

network; for example, a home agent 7 is a router connected to the home network

1 and a foreign agent 8 is a router connected to a foreign network 2. The mobile

20   node 6 may optionally solicit an Agent Advertisement message from any local

mobility agents via an Agent Solicitation message. By receiving Agent

Advertisements, the mobile node 6 is able to determine whether it is on its home

network 1 or on a foreign network 2, 3, 4.

25   While the mobile node 6 is on its home network, it has no need for mobility

services. When the mobile node 6 is temporarily moved to a foreign network 2,

as shown by the dotted box in Figure 1a, it obtains a temporary care-of address

on the foreign network 2. This can be a foreign agent care-of address, which is

the IP address of the foreign agent, obtained by receiving or soliciting Agent

30   Advertisements from any foreign agents based on the foreign network 2.

Alternatively, the care-of address may be obtained by using an external

assignment mechanism, such as Dynamic Host Configuration Protocol (DHCP)
(the reader is referred to RFC 1541 for further information), in which case it is
known as a co-located care-of address.

5   The mobile node 6 then registers its new care-of address with its home agent 7 by
exchanging Registration Request and Registration Reply messages with it.
Registration provides a mechanism by which mobile nodes can communicate
their current reachability information to their home agent. The registration
process is described in more detail below, assuming that the mobile node 6 on

10   the foreign network 2 is registering a foreign agent care-of address received via an
Agent Advertisement from, for example, foreign agent 8.

First, the mobile node 6 sends a Registration Request message to the foreign
agent 8, which processes it and forwards it to the mobile node's home agent 7.

15   The Registration Request message includes the IP address of the foreign agent.
The home agent 7 sends a Registration Reply message to the foreign agent 8
granting (or denying) the registration request. The foreign agent 8 processes this
Reply and forwards it to the mobile node 6. This process establishes a
temporary address for the mobile node 6 to which datagrams can be delivered

20   while the node is roaming away from its home network 1.

If the mobile node 6 is returning to its home network 1 having been on a foreign
network 2, it deregisters with its home agent 7, through exchange of Registration
Request and Registration Reply messages.

25
Referring to Figure 1b, when a correspondent node (CN) 9 attached to a
network 4 sends a message intended for the mobile node 6, while it is connected
to the foreign network 2, the message is intercepted by the home agent 7, as
shown by arrow A. The home agent 7 encapsulates the datagrams forming the

30   message with the care-of address for the mobile node 6, in this example being the
IP address of the foreign agent 8, and forwards the message to the foreign agent 8.

The transmission of the encapsulated datagrams, shown by arrow B, is known as tunnelling. The foreign agent 8 receives the datagrams, decapsulates them and forwards them to the mobile node 6, as shown by arrow C. Messages from the mobile node 6 to other nodes in the Internet need not follow this route, but may

5   be sent directly via an appropriate router, which may be foreign agent 8.

The concepts of encapsulation and tunnelling are described in detail in RFC 2003, "IP Encapsulation within IP". The model is that a tunnel is the path followed by a datagram while encapsulated. Encapsulation allows an IP

10 datagram to be hidden from intermediate routers which would incorrectly attempt to route it to the mobile node. Instead, the datagram is routed between the encapsulator and a knowledgeable decapsulator, such as a foreign agent, which can correctly route the datagram. The home agent 7 and foreign agent 8 are known as the endpoints of the tunnel. In the case of the co-located care-of

15 address, the mobile node itself acts as an endpoint of the tunnel.

US-A-5 325 362 (Aziz) and Johnson D B: "Ubiquitous Mobile Host Internetworking", Proceedings of the workshop on workstation operating systems, 14 October 1993, pp. 85 - 90, XP000672247, disclose tunnelling schemes

20 which enable efficient routing of data to a mobile node to be maintained when the mobile node moves between its home network and foreign networks.

To enable the tunnelling process described above to function correctly, the home agent 7 maintains reachability information for the mobile node 6, in a form

25 known as a mobility binding. This is the association of the mobile node's identity with a care-of address and a parameter known as the Lifetime, which is the number of seconds remaining before the registration of the node 6 with the home agent 7 expires. The aim behind a Lifetime value is to maintain the dynamic nature of the system, with a binding expiring within a set time unless

30 positively maintained by the mobile node 6. As an example, the default Router Advertisement Lifetime value, which may be used where a mobile node is

registering with a foreign agent which it has acquired via an Agent Advertisement, is 1800 seconds.

5   On receipt of a Registration Request message, the home agent 7 creates or modifies the mobility binding, for example, by re-setting the Lifetime value where the Request is a re-registration request and the mobility binding has not yet expired. If the Lifetime value for a given mobility binding expires before a re-registration request has been received, the home agent 7 deletes the mobility binding from its record. The Registration Reply message from the home agent 7

10   informs the mobile node 6 (via the foreign agent 8) of the status of its Request, including the Lifetime value allocated by the home agent 7.

     Mobile IP supports multiple simultaneous mobility bindings, so that each mobile node 6 may register with a number of foreign agents and so obtain a number of

15   care-of addresses. This is particularly useful where a mobile node using a wireless interface to a network, for example an RF interface, moves within range of more than one foreign agent. For example, if the mobile node is a router on an aircraft, then while the aircraft is in flight, the router may from time to time register with a series of foreign agents based on the ground below using a radio

20   link.

     In the case of multiple simultaneous mobility bindings, the home agent 7 retains its existing list of mobility bindings when it receives a Registration Request containing the IP address of a new foreign agent. If the Lifetime value of one

25   mobility binding expires, the home agent 7 deletes that mobility binding from its record, but retains in its record the other non-expired bindings.

     Figure 2 shows a situation in which the mobile node 6 is within range of two foreign agents 10, 11. Once the registration process with each foreign agent 10,

30   11 is complete, Mobile IP provides for the home agent 7 to tunnel a separate copy of each arriving datagram to each care-of address. The mobile node 6 will

therefore receive multiple copies of each datagram depending on the number of foreign agents with which it is registered, in this case, two. This improves the bit error rate of the transmission.

5   The very nature of a mobile communications system means that links may be being constantly established, broken and re-established. The home agent 7 may lose contact with the mobile node 6 through one foreign agent, only to have it re-established through another foreign agent. However, the home agent 7 may lose contact with the mobile node 6 entirely, so that the Lifetime of each of its

10   mobility bindings will eventually expire. When this occurs, the home agent 7 deletes each mobility binding, when it expires, from its record for that mobile node 6. Once all the mobility bindings have expired, the mobile node is no longer reachable through the home agent 7. Data sent to the mobile node 6 cannot therefore be routed to its destination. This type of event is dealt with by

15   a protocol known as the Internet Control Message Protocol (ICMP), which is an integral part of all IP implementations. The functions of ICMP include dealing with error reporting and reachability testing as well as performance measurement and congestion control. In the event that the home agent 7 has no mobility bindings specifying a route to the mobile node 6, the home agent 7

20   generates an ICMP Destination Unreachable error report and sends this to the correspondent node 9 with a code indicating that the destination network is unreachable.

It is also possible for the home agent 7 to be unaware that the mobile node 6 is

25   no longer reachable, for instance because the node becomes unreachable soon after re-registering its presence with the home agent 7, so that the Lifetime of the corresponding mobility binding has not yet expired. In this case, the home agent 7 will continue sending encapsulated datagrams through the tunnel, but the foreign agents 10, 11 will be unable to relay these to the mobile node. ICMP

30   error messages will therefore be generated which will be relayed to the correspondent node 9 as before.

Although ICMP is useful in providing some indication of communication difficulties, it does not resolve the problem of ensuring that data reaches its destination, but simply notifies the existence of a problem. Further, there are

5   times when the mobile node 6 itself knows that it will be unreachable at its present location and requires some method of call forwarding. It is further inconvenient if, after becoming unreachable, the mobile node 6 subsequently becomes contactable again and re-registers with the home agent 7, but the data destined for it is no longer available.

10

Summary of the Invention

To address the above problems, the present invention provides a method of routing data directed to a mobile node in a communications system, comprising the steps of maintaining reachability information for the mobile node and

15   receiving data directed to the mobile node, characterised by setting a destination to which the received data is to be sent when the reachability information indicates that the mobile node is unreachable.

The data destination may comprise a proxy node and the method may further

20   comprise instructing the proxy node to send received data to the mobile node when the reachability information indicates that the mobile node has become reachable.

The data destination may be set in accordance with a user preference, which may

25   also specify the conditions in which the user specified destination is to be used. Advantageously therefore, the user may control the circumstances in which a proxy destination is used, while the system can be arranged so that if the user does not specify a default destination, such a destination is always provided when the mobile node is not reachable from the home agent.

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The reachability information may be a single destination address or a plurality of addresses, such as the care-of addresses provided by a plurality of foreign agents in a mobile IP based system.

5   The invention further provides a mobile communications system comprising a mobile node, means for maintaining reachability information for the mobile node and means for receiving messages directed to the mobile node, characterised by a service controller configured to set a destination for a message directed to the mobile node when the reachability information indicates that the mobile

10   node is unreachable.

According to the invention, there is further provided a method of routing data directed to a mobile host which is away from its home network, comprising the steps of maintaining a record of locations through which the data can be routed

15   to the mobile host, and in the event that the data cannot be routed to the mobile host through any of the locations specified in the record, then routing the data to an alternative destination from which it is available for subsequent retrieval to the mobile host.

20   In accordance with the invention, there is also provided a mobile communications system comprising a mobile host movable between its home network and a plurality of connected communications networks, a router configured to route data intended for the mobile host to a location through which the data can be sent to the mobile host, when the mobile host is away

25   from its home network, and a service controller configured to intervene so as to send the data to an alternative location, when the data cannot be sent to the mobile host.

The invention also provides a mobile communications system comprising a

30   mobile node and means for receiving a message directed to the mobile node,

characterised by means for controlling the destination to which the message is to be sent in accordance with a user preference.

The system can further comprise means for maintaining reachability information for the mobile node, and the controlling means can be operative to set a user defined destination for the message when the reachability information indicates that the node is unreachable.

The invention further provides a method of routing data directed to a mobile node in a communications system, comprising the steps of receiving data directed to the mobile node, and setting the destination to which the data is to be sent in accordance with a user preference.

Brief Description of the Drawings

Embodiments of the invention will now be described by way of example with reference to the accompanying drawings, in which:

Figure 1a is a schematic diagram of the general arrangement of a conventional mobile IP based system;

Figure 1b shows the flow of data to a mobile node attached to a foreign network in the system of Figure 1a;

Figure 2 is a schematic block diagram showing the registration of a mobile node with multiple foreign agents in a conventional mobile IP based system; and

Figure 3 is a schematic block diagram of a system according to the present invention for use with the method according to the present invention.

Detailed Description

Referring to Figure 1b, in a known IP based system such as the Internet, the home agent 7 plays a passive role in data transmission to the mobile node 6. When the home agent 7 intercepts a data message destined for the mobile node 6, its only options are to tunnel the message to the mobile node 6 based on its

record of the current location of that node, or, if it has no reachability information, to return an ICMP error.

Referring to Figure 3, in a system according to the invention, the home agent 7,

5 for example a PC running software which provides routing functionality, is re-configured so that before any datagrams are tunnelled to the foreign agents 10, 11, a service controller 13 can intervene. The functions of the service controller 13 as defined below can be readily implemented in software on a general purpose computer. The service controller 13 comprises a user interface 14 as well as

10 processing capability to execute user applications 15. It also provides data storage in the form of a temporary store 16 and a user preferences database 17. The principal function of the service controller 13 is to determine appropriate mobility bindings for the home agent 7 based on current binding information from the home agent, together with user or system defined preferences.

15

Where the mobile node 6 is reachable from the home agent 7, the service controller may intervene to set new mobility bindings, where the user preferences specify that it should do so.

20 In the event that the mobile node 6 is not reachable from the home agent 7, the service controller 13 can be instructed always to intervene, so that incoming data is always sent to an appropriate destination. This may be, for example, the temporary store 16, but, in a preferred embodiment of the invention, the appropriate destination is a proxy node 18, which can store data destined for the

25 mobile node 6 when the mobile node is unavailable, and effectively takes the place of the correspondent node 9 when the mobile node 6 subsequently becomes available on the network.

A preferred destination, for use either in particular circumstances, or as a general

30 default destination, may be specified by a user through the user interface 14, or by a user application 15 running on the service controller 13. If no preferred

destination is specified by the user, the system administrator may in any case set
up a default destination, for example the proxy node 18.

Preferences requested by a user may be stored in the user preferences database 17.
The preference may indicate an alternative destination, such as one of a plurality
of alternative proxy nodes 19a-n, for any messages addressed to the mobile node
6 and may also contain codes specifying the circumstances in which the
alternative destination is to be used. For example, the database 17 may specify
that the alternative destination is only to be used at or after a particular date or
time. The database 17 may further contain multiple destination addresses, each
to be used in different circumstances. For example, different destinations may be
used in different time periods or in response to different types of message, so that
file transfers may be routed to one destination, proxy node 19a say, while video
calls are routed to another, such as proxy node 19b.

The above examples are not intended to be limiting, since the database 17 may
store any data format so as to allow the service controller 13 to be configured to
provide intelligent network services in line with the requirements of any
particular system with which the service controller 13 is used.

The operation of the system is described below with reference to Figure 3.

When a message, in the form of a stream of datagrams, is received from a
correspondent node 9 destined for the mobile node 6, the home agent 7 checks
its internal record for unexpired mobility bindings for that node.

If the home agent's record reveals no mobility bindings recorded for the mobile
node 6, the home agent 7 signals the service controller 13. The service
controller 13 then examines the user preferences database 17 and provides the
home agent 7 with a default binding which is active only when there are no

other bindings. If no user preference is supplied, the service controller 13 uses the default provided by the system administrator.

While the mobile node 6 is unavailable, and so the default binding is active, any
message intended for the mobile node 6 will be tunnelled to the preferred destination, for example, the proxy node 18. The proxy node 18 decapsulates the message and stores it. When the home agent 7 receives a message from the correspondent node 9, the service controller 13 may also instruct the home agent 7 to send back a message, for example, a previously stored user message, to the
correspondent node 9.

At some time after the message from the correspondent node 9 is sent, the mobile node 6 becomes available again, either on its home network 1, in which case it deregisters with the home agent 7, or on a foreign network 2, 3, 4, in
which case it re-registers a new care-of address with the home agent 7. In either case, the home agent 7 updates the service controller 13, which instructs the proxy node 18 to send the stored message to the mobile node 6. As far as the mobile node 6 is concerned, the proxy node 18 therefore takes the place of the correspondent node 9 and sends the stored message to the mobile node 6 in
accordance with the conventional Mobile IP protocol. For example, if the mobile node 6 has returned to its home network 1, then the proxy node 18 sends the message directly to the mobile node 6, ignoring the home agent 7. If, on the other hand, the mobile node 6 is on a foreign network 2, 3, 4 and registered with the home agent 7, the proxy node 18 sends the message to the home agent 7 for
onward transmission to the mobile node 6 through the appropriate care-of address.

To deal with the possibility that the home agent 7 is unaware that the mobile node 6 is no longer reachable, for instance because the node becomes unreachable
soon after re-registering its presence with the home agent 7, the foreign agents 10, 11 are configured to send back all ICMP error messages to the home agent 7, so

that the home agent 7 can modify the bindings. This ensures that such error

messages are not sent back to the correspondent node 9, so that, as far as the

correspondent node 9 is concerned, the mobile node 6 is available to it, and the

message will be routed in accordance with the settings specified at the service

5   controller 13.

Where the home agent's record contains unexpired mobility bindings in respect

of at least one of the foreign agents 10, 11, the home agent 7 then requests the

service controller 13 to check whether a user preference is recorded in the user

10   preferences database 17. As described above, the user database 17 also records

information indicating the circumstances in which the user preference is to be

used. If no user preference is indicated, or if the conditions or circumstances of

use are not satisfied, the home agent 7 sends the message to the mobile node 6 via

the appropriate foreign agents 10, 11. If an active user preference is found, the

15   service controller 13 acts in accordance with that preference to amend the home

agent's mobility bindings. For example, the preference may specify that, despite

the mobile node 6 being reachable, messages should be sent to proxy node 19a

during some predetermined period. The service controller 13 therefore amends

the home agent's mobility bindings at the appropriate times so as to put the

20   preference into effect. At the expiry of the predetermined period, the service

controller 13 instructs the proxy node 19a to send the stored message to the

mobile node 6 in accordance with the conventional Mobile IP protocol, as

described above.

25   The system described above is capable of working with real-time

telecommunications services such as video calls, enabling on-the-fly redirection of

such services to a mobile node via a proxy node when the mobile node is

unavailable.

Although the above examples have been described with reference to the Internet, the invention is applicable to any network based on the Internet Protocol and the principles may be extended to systems based on other network protocols.

Claims

1.   A method of routing data directed to a mobile node (6) in a communications system, comprising the steps of:

5   maintaining reachability information for the mobile node; and
receiving data directed to the mobile node; **characterised by**
setting a destination (18, 19a – n) to which the received data is to be sent when the reachability information indicates that the mobile node is unreachable.

10   2.   A method according to claim 1, wherein the data destination comprises a proxy node (18).

3.   A method according to claim 2, further comprising instructing the proxy node to send received data to the mobile node when the reachability information

15   indicates that the mobile node has become reachable.

4.   A method according to any preceding claim, comprising setting the data destination in accordance with a user preference.

20   5.   A method according to claim 4, wherein the user preference specifies the conditions in which the user specified destination is to be used.

6.   A method according to any preceding claim, wherein the reachability information comprises at least one destination address.

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7.   A method according to claim 11, further comprising storing the data at said alternative destination until the mobile host becomes available.

8.   A method according to any preceding claim, wherein the

30   communications system comprises an Internet Protocol (IP) based system.

9.   A method according to claim 7, wherein the reachability information is
maintained by a home agent router (7).

10.   A method according to claim 7 or 8, wherein the destination address is a
care-of address for the mobile node.

11.   A mobile communications system comprising:
a mobile node (6);
means for maintaining reachability information for the mobile node; and
means for receiving messages directed to the mobile node; **characterised by**
a service controller (13) configured to set a destination for a message directed to
the mobile node when the reachability information indicates that the mobile
node is unreachable.

12.   A method of routing data directed to a mobile host (6) which is away
from its home network (1), comprising the steps of:
maintaining a record of locations through which the data can be routed to the
mobile host, and in the event that the data cannot be routed to the mobile host
through any of the locations specified in the record, then routing the data to an
alternative destination (18, 19a – n) from which it is available for subsequent
retrieval to the mobile host.

13.   A method according to claim 12, further comprising storing the data at
said alternative destination until the mobile host becomes available.

14.   A mobile communications system comprising:
a mobile host (6) movable between its home network (1) and a plurality of
connected communications networks (2, 3);
a router (7) configured to route data intended for the mobile host to a location
(10, 11) through which the data can be sent to the mobile host, when the mobile
host is away from its home network; and

a service controller (13) configured to intervene so as to send the data to an
alternative location (18, 19a – n), when the data cannot be sent to the mobile
host.

5   14.   A mobile communications system comprising:
a mobile node (6); and
means (7) for receiving a message directed to the mobile node; **characterised by**
means (13) for controlling the destination to which the message is to be sent in
accordance with a user preference.

10

15.   A system according to claim 14, further comprising means for
maintaining reachability information for the mobile node, wherein the
controlling means is operative to set a user defined destination for the message
when the reachability information indicates that the node is unreachable.

15

16.   A method of routing data directed to a mobile node (6) in a
communications system, comprising the steps of:
receiving data directed to the mobile node; and
setting the destination to which the data is to be sent in accordance with a user
20   preference.

17.   A mobile communications system substantially as hereinbefore described
with reference to the accompanying drawings.

25   18.   A method of routing data directed to a mobile node in a communications
system, substantially as hereinbefore described with reference to the
accomanying drawings.

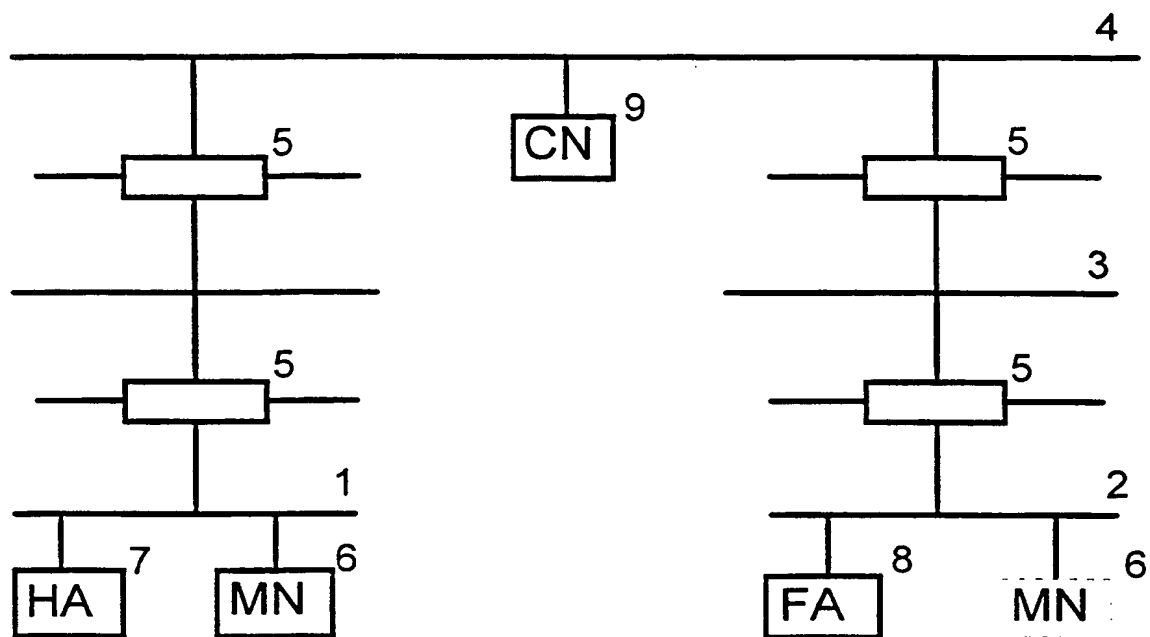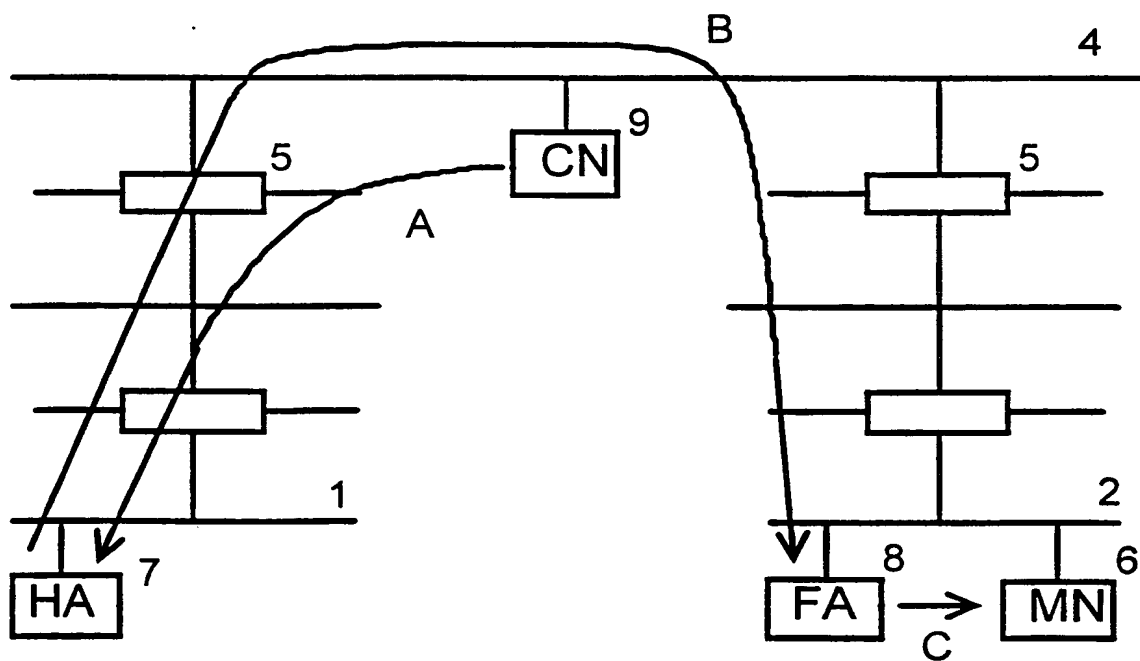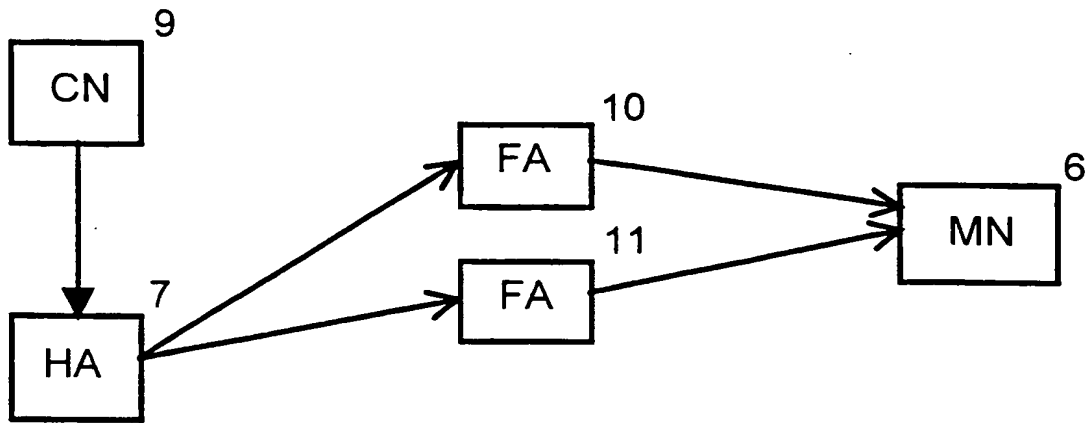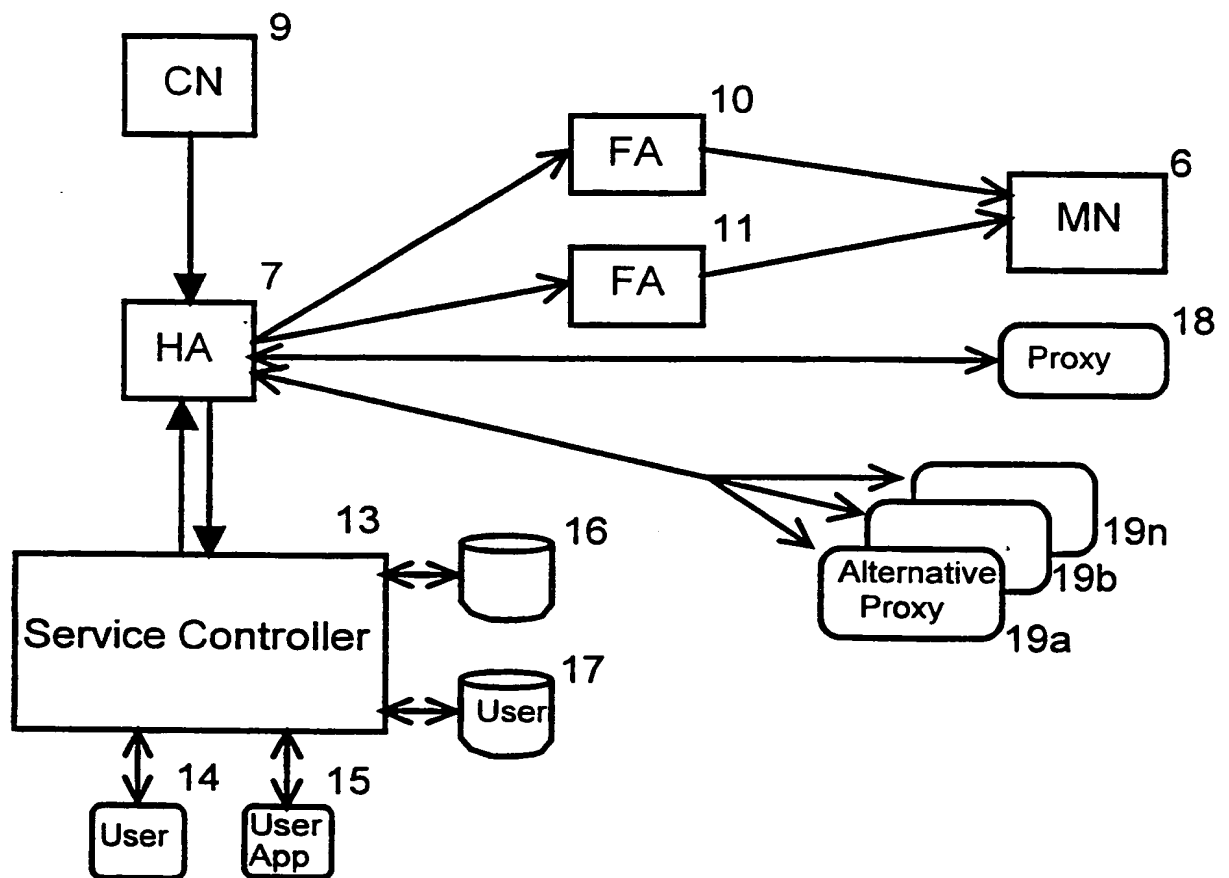Figure 1a

Figure 1b

Figure 2

Figure 3

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6   H04L12/28

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6   H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JOHNSON D B: "UBIQUITOUS MOBILE HOST INTERNETWORKING" PROCEEDINGS OF THE WORKSHOP ON WORKSTATION OPERATING SYSTEMS,14 October 1993, pages 85-90, XP000672247 see paragraph 3.2	1-3,6, 8-10,14, 17,18
Y	see paragraph 3.3	4,5,15
X	US 5 325 362 A (AZIZ ASHAR) 28 June 1994 see abstract see column 5, line 30 - column 8, line 43	1-3,6, 8-10
P,X	WO 98 26621 A (ERICSSON TELEFON AB L M) 18 June 1998	12,14,16
P,Y	see abstract see page 6, line 6 - line 21 see page 8, line 3 - line 11	4,5,15

-/--

☒ Further documents are listed in the continuation of box C.   ☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 April 1999	06/05/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Perez Perez, J

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication.where appropriate, of the relevant passages	Relevant to claim No.
A	MYLES A ET AL: "COMPARISON OF MOBILE HOST PROTOCOLS FOR IP" INTERNETWORKING: RESEARCH AND EXPERIENCE, vol. 4, no. 4, December 1993, pages 175-194, XP000672445 see the whole document -----	1-18

6

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
US 5325362	A	28-06-1994	EP 0655847 A		31-05-1995
			JP 7170286 A		04-07-1995
WO 9826621	A	18-06-1998	AU 5423598 A		03-07-1998

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 03 32803	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)

International application No. PCT/GB98/03718	International filing date *(day/month/year)* 11/12/1998	Priority date *(day/month/year)* 17/12/1997

International Patent Classification (IPC) or national classification and IPC
H04L12/28

Applicant

BRITISH TELECOMMUNICATIONS PUBLIC L. C. ....et al.

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 5 sheets.

3. This report contains indications relating to the following items:

   I   ☒   Basis of the report

   II   ☐   Priority

   III   ☒   Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

   IV   ☐   Lack of unity of invention

   V   ☒   Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement

   VI   ☐   Certain documents cited

   VII   ☐   Certain defects in the international application

   VIII ☒   Certain observations on the international application

Date of submission of the demand 10/06/1999	Date of completion of this report **2 1. 03. 00**
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Hamer, J Telephone No. +49 89 2399 8827

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB98/03718

I. Basis of the report

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

Description, pages:

1-7,10-14	as originally filed		
8,9	as received on	25/11/1999 with letter of	22/11/1999

Claims, No.:

1-16	as received on	25/11/1999 with letter of	22/11/1999

Drawings, sheets:

1/2,2/2	as originally filed

2. The amendments have resulted in the cancellation of:

- ☐ the description,   pages:
- ☐ the claims,   Nos.:
- ☐ the drawings,   sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been examined in respect of:

- ☐ the entire international application.

- ☒ claims Nos. 15,16.

because:

☐   the said international application, or the said claims Nos. relate to the following subject matter which does
        not require an international preliminary examination (*specify*):

☒   the description, claims or drawings (*indicate particular elements below*) or said claims Nos. 15,16 are so
        unclear that no meaningful opinion could be formed (*specify*):

     see separate sheet

☐   the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion
        could be formed.

☐   no international search report has been established for the said claims Nos. .

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial
        applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Yes:	Claims	1-14
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-14
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-14
	No:	Claims	

2. Citations and explanations

     see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the
claims are fully supported by the description, are made:

     see separate sheet

III- No Opinion

Claims 15 and 16 contain no technical features whatsoever and an opinion cannot thus be given on these claims.

V- Reasoned Statement

1.   **Claim 1**

Claim 1 is concerned with a method of routing data directed to a mobile node in a communications system. One example of such a node could be a node serving a mobile data network within an aircraft. If messages are addressed to a mobile node, it is obvious that they must be routed to the node, i.e. tables must be maintained which contain the current location, i.e. address of the node.

The documents JOHNSON D B: 'UBIQUITOUS MOBILE HOST INTERNETWORKING' PROCEEDINGS OF THE WORKSHOP ON WORKSTATION OPERATING SYSTEMS,14 October 1993, pages 85-90, and US-A-5 325 362 (AZIZ ASHAR), both cited in the international search report, are concerned with routing of messages to mobile nodes and the updating of node reachability data. The subject-matter of these documents corresponds to that of the preamble of claim 1.

The subject-matter of claim 1 is characterised over these disclosures in that it is concerned with the case when the mobile node is unreachable. This problem is not disclosed in either of the above mentioned documents. The solution proposed in claim 1 is for a destination address to be set to which such data is to be sent in the event of the mobile node being unreachable.

As this problem is not known and its solution absent from any of the available prior art documents, the subject-matter of claim 1 involves an inventive step and claim 1 meets the requirements of Articles 33(2) and (3) PCT.

2.   **Independent claims 11, 12 and 14**

The subject-matter of independent claims 11, 12 and 14 is essentially the same as
that of claim 1. Claim 11 is expressed in terms of an apparatus and claims 12 and
14 overlap with claims 1 and 12. Thus for the same reasons outlined above,
claims 11, 12 and 14 also meet the requirements of Articles 33(2) and (3) PCT.

3.   **Dependent claims 2 to 10 and 13**

The subject-matter of dependent claims 2 to 10 and 13 includes features which
further restrict the scope of claims 1 and 12 respectively. As a result, these claims
also meet the requirements of Articles 33(2) and (3) PCT.

VIII-Certain Observations

The subject-matter of claims 1 and 12 and that of claims 11 and 14 overlaps and
states essentially the same subject- matter. As a result, the claims are not concise
and do not meet the requirements of Article 6, PCT.

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 03 32803	**FOR FURTHER ACTION**	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
International application No. PCT/GB 98/ 03718	International filing date *(day/month/year)* 11/12/1998	(Earliest) Priority Date *(day/month/year)* 17/12/1997

Applicant BRITISH TELECOMMUNICATIONS PUBLIC L. C. ....et al.

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of ____3____ sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language,** the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

   [ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

   b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

   [ ] contained in the international application in written form.

   [ ] filed together with the international application in computer readable form.

   [ ] furnished subsequently to this Authority in written form.

   [ ] furnished subsequently to this Authority in computer readble form.

   [ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   [ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. ___1B___

   [ ] as suggested by the applicant.   [ ] None of the figures.

   [X] because the applicant failed to suggest a figure.

   [ ] because this figure better characterizes the invention.

Form PCT/ISA/210 (first sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6   H04L12/28

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6   H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category°	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JOHNSON D B: "UBIQUITOUS MOBILE HOST INTERNETWORKING" PROCEEDINGS OF THE WORKSHOP ON WORKSTATION OPERATING SYSTEMS, 14 October 1993, pages 85-90, XP000672247 see paragraph 3.2	1-3,6, 8-10,14, 17,18
Y	see paragraph 3.3	4,5,15
X	US 5 325 362 A (AZIZ ASHAR) 28 June 1994 see abstract see column 5, line 30 - column 8, line 43	1-3,6, 8-10
P,X	WO 98 26621 A (ERICSSON TELEFON AB L M) 18 June 1998	12,14,16
P,Y	see abstract see page 6, line 6 - line 21 see page 8, line 3 - line 11	4,5,15

-/--

| X | Further documents are listed in the continuation of box C. | X | Patent family members are listed in annex. |

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&". document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 April 1999	06/05/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Perez Perez, J

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Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	MYLES A ET AL: "COMPARISON OF MOBILE HOST PROTOCOLS FOR IP" INTERNETWORKING: RESEARCH AND EXPERIENCE, vol. 4, no. 4, December 1993, pages 175-194, XP000672445 see the whole document -----	1-18

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
US 5325362	A	28-06-1994	EP	0655847 A	31-05-1995
			JP	7170286 A	04-07-1995
WO 9826621	A	18-06-1998	AU	5423598 A	03-07-1998